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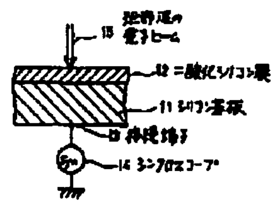
(54) METHOD FOR MEASURING FILM THICKNESS

(57) Abstract:

PURPOSE: To exactly measure the thickness of a film having a small area in a non-contact and non-destructive state by projecting an electron beam of a square wave on the actual film surface and measuring the film thickness from the waveform of the current penetrating the film surface.

CONSTITUTION: A silicon dioxide film 12 (thin film) is formed on the surface of a silicon substrate 11. A synchroscope 14 is connected via a connecting terminal 13 and is grounded. The electron beam 15 of the square wave accelerated by a prescribed acceleration voltage is projected like an arrow on the surface region of the film 12. Then the beam current of the square wave flows to the substrate 11 and the film 12 and the current waveform is detected on the synchroscope 14. The waveform of the current past the film 12 and the substrate 11 is more approximate to the waveform of the original current as the acceleration voltage is larger and as the film thickness is smaller. The film thickness is thus made measurable by measuring the delay time from the time when the original square wave of the peak value of the current waveform is impressed on the basis of said value.



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㊹発明の名称　膜厚の測定方法

㉑特　願　昭60-158654
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明　細　書

1. 発明の名称

膜厚の測定方法

2. 特許請求の範囲

電子ビーム波形がパルス状の電子ビーム(15)を、それぞれ異なる厚みを有する膜(12)の表面に印加し、

予めそれぞれの膜厚に対応して、該膜の導通電流波形の印加時からピーク値迄の遅れ時間を測定して、相関関係（第1図）を求めておき、

膜の厚さを測定する際には、該膜に矩形波の電子ビームを印加して、該成膜に導通する電流波形の印加時からピーク値迄の遅れ時間を求め、

この遅れ時間を前記相関関係と比較することにより、膜の膜厚を測定することを特徴とする膜厚の測定方法。

3. 発明の詳細な説明

〔概要〕

本発明は、膜厚の測定方法であって、1000Å以下の極めて薄い膜厚を測定する方法であり、また被測定膜を非接触、非破壊で膜厚を測定するために、成膜した膜面に加速電圧を変化した矩形波の電子ビームを投射することにより、膜を流れる矩形波の電子ビーム電流の波形を観測し、予め求めてある、膜厚と加速電圧と波形との相関を求めた図表と対照することにより膜厚の測定を行うものである。

〔産業上の利用分野〕

本発明は、膜厚の測定方法に係わり、特に矩形波の電子ビームを使用することによる極薄膜の厚みの測定方法に関する。

半導体装置の高集積化が進み、高密度化と微密化により、パターニングが微細になると共に、成膜される膜厚も極めて薄い膜形成が必要になり、さらにその膜厚を正確に測定することが要求されるようになった。

従来、1000Å以下程度の薄膜では、膜厚の測定には被測定膜に厚みの段差を形成し、それに光を投射して、光学的反射法により測定するか、光学

的な干渉光を利用して膜厚を測定する方法等が採用されている。

しかしながら、この場合には、被測定物を破壊することになり、また、微小領域の膜厚を光学的な手段で測定するためには原理的に不利であり、精度も不正確になるという欠点がある。

このような理由から、被測定物を非接触で非破壊の状態で、小面積の薄い膜厚でも正確に測定できる方法が要望されている。

〔従来の技術〕

第5図は、従来の膜厚を測定するための模式要部断面図である。

被測定物が光反射性であるシリコン等の場合には、下層物体1を例えばシリコンとし、その表面に薄膜2として、例えば二酸化シリコン膜があるものとし、その二酸化シリコン膜の膜厚を測定する場合には、薄膜2を破壊して段差3を形成し、その段差部分に、膜厚とほぼ同程度の波長を有する、例えば波長が約6000Åのタリウム光源等を用いた矢印のような光を投射して、それぞれの段差の差異による反射光をディスプレイ装置4に描画して、その画像5から、膜厚を測定する方法が広く採用されている。

第6図は、従来の他の測定方法として、下層物体6の上層に光透過性の薄膜7の膜厚を測定する際に採用されるもので、被測定物の薄膜7に斜め方向から投射光8を投射し、薄膜7を透過して基板6から反射される反射光9と、薄膜6の表面から反射される反射光10との位相差の比較から、薄膜の厚みを求める方法である。

このような従来の方法では、光の被測定物からの光反射や光屈折が、膜厚測定領域との形状にも関連して複雑になり、その結果測定精度が低く、また被測定物に段差を形成する場合には、被測定物を破壊しなければならぬという欠点がある。

〔発明が解決しようとする問題点〕

従来の光学的方法による膜厚測定方法では、被測定物を破壊して段差を形成するとか、また被測定物の複雑な光学的特性のために、精度が低く、さらに小面積領域の膜厚が測定不可能等の問題がある。

〔問題点を解決するための手段〕

本発明は、上記問題点を解決した膜厚の測定方法を提供するもので、その解決の手段は、予め、電子ビーム波形がパルス状の電子ビームを、複数の厚みの異なる膜の表面に印加して、それぞれの膜厚に対応した膜の導通電流波形の印加時からピーク値迄の遅れ時間とを測定して、膜厚と加速電圧および電流波形のピーク迄の遅れ時間との相関関係を求めておき、実際に、成膜した膜の厚みを測定する際には、その膜に矩形波の電子ビームを印加して、その膜内に流れる電流波形から、電圧印加時からピーク値迄の遅れ時間を測定し、この測定値を既知の相関関係と比較することで、膜の膜厚を測定するように考慮したものである。

〔作用〕

本発明は、ある物質に所定の加速電圧で加速された電子ビームを投射すると、電子ビームがその物質に浸入する到達深さは、その物質に固有の密度と、電子ビームの加速電圧にのみ関係し、従って膜厚よりも電子の到達深さが大きければ、膜の導通電流が原型の矩形波の波形と同形のまま貫通電流（波形のピーク値が立ち上がり時とほぼ一致）となるし、反対に膜厚よりも電子の到達深さが小であれば、膜の導通電流は原型の矩形波の波形とかなり異なる波形の貫通電流（矩形波が山型になり、ピーク値が立ち上がり時から遅れる）になることを利用したものである。

そのため、予め、それぞれ異なる厚みの物質について、加速電圧をパラメータにして膜を貫通する矩形波の電流波形を測定すると、その物質について、加速電圧、波形のピーク値迄の遅れ時間，膜厚の相関関係が得られる。

この既知の相関関係を利用して、実際の膜面に矩形波の電子ビームを投射して、その膜面貫通電流波形から、膜厚を測定するものである。

〔実施例〕

一般に、物質に電子ビームを投射すると、電子はその物質の或る深さ迄到達するが、この場合に周知の下記の式が成立する。

$$Rg = 4.6 \times 10^{-6} E \ / \rho \quad (1)$$

(1)式で、

Rg ＝物質内の電子の到達深さ(cm)

ρ ＝物質の密度 (g/㎤)

E ＝電子ビームの加速電圧(KV)

従って、加速電圧が大きい程、また密度が小である程、電子はその物質の深い部分まで到達し、反対に加速電圧が小で、密度が大である程、電子はその物質の浅い部分までしか到達できない。

第1図は、所定の物質で薄膜を形成し、その薄膜に矩形波の電子ビームを投射した時に、矩形波の電子ビームが薄膜を通過した矩形波が、矩形波が印加されてからピーク値迄の時間と、矩形波の電子ビームの加速電圧との相関図であり、薄膜の厚みをパラメータにして表している。

第2図は、上記の関係図を求めるために行った膜厚の測定方法の断面図である。

シリコン基板11の表面に、例えば二酸化シリコン膜12の薄膜を形成し、基板には接続用端子13を介してシンクロスコープ14に接続して接地し、その薄膜の表面領域に、所定の加速電圧で加速された矩形波の電子ビーム15で、矢印のように投射する。

シリコン基板11と二酸化シリコン膜12には、矩形波のビーム電流が流れ、シンクロスコープ14に電流波形が検知されるので、この波形からピーク値迄の遅れ時間を求めることができる。

第3図(a)～第3図(f)は、薄膜に印加する矩形波の電子ビームと薄膜の厚さと基板と薄膜を貫通した電流波形とを、それぞれ比較している。

第3図(a)は薄膜に印加する原矩形波であり、第3図(b)～第3図(f)は、それぞれ加速電圧が5KV、10KV、20KVが印加された際の膜厚を示している。

即ち第3図(b)の波形は加速電圧が5KVで5000Åの厚み、10KVで15000Åの厚み、20KVで20000Åの膜厚の時の波形を示している。

同様に第3図(c)の波形は加速電圧が5KVで4000Åの厚み、10KVで12000Åの厚み、20KVで40000Åの膜厚の時の波形を示し、第3図(d)の波形は加速電圧が5KVで2000Åの厚み、10KVで6000Åの厚み、20KVで20000Åの膜厚の時の波形を示し、第3図(e)の波形は加速電圧が5KVで1000Åの厚み、10KVで3000Åの厚み、20KVで10000Åの膜厚の時の波形を示し、第3図(f)の波形は加速電圧が5KVで500Åの厚み、10KVで1500Åの厚み、20KVで5000Åの膜厚の時の波形を示している。

即ち第3図(b)の波形はシンクロスコープで測定された、薄膜と基板を通過する電流波形図であるが、それぞれ加速電圧が大きくなる程、また膜厚が薄くなる程、薄膜と基板を通過してきた電流波形図は、原電流波形図に近似してくる。

従って、電流波形のピーク値（図でPで示している）を基準にして、その値の原矩形波を印加した時間からの遅れ時間を測定することにより、膜厚が測定できることになる。

この遅れ時間は、加速電圧によるがnSec乃至mSec程度である。

第4図は、本発明の実施例である薄膜の測定方法を示す模式断面図である。

シリコン基板21の表面に、二酸化シリコン膜22があり、特に直径が数μm程度の凹部23を形成して、その部分の薄膜24の厚みを測定するものとする。

測定方法は、矢印で示す矩形波の電子ビーム25のビームスポットを、凹部にある薄膜24の寸法に合わせて絞り、薄膜にビーム投射することにより、シンクロスコープ26に映像される電流波形を観測して、ピーク値の遅れを測定し、第1図で説明した予め求めてある相関図に照合して、容易に膜厚を測定することができる。

〔発明の効果〕

以上、詳細に説明したように、本発明による膜

厚測定方法により、極薄膜の厚みを測定することが可能となり、膜厚の正確測定により高精度の高集積回路半導体装置を供し得るという効果大なるものである。

4. 図面の簡単な説明

第1図は、膜厚をパラメータとした矩形波のピーク値遅の時間と、電子ビームの加速電圧との相関図、

第2図は、本発明による膜厚測定方法を説明するための模式要部断面図である。

第3図(a)～第3図(f)は、電流波形図、

第4図は、本発明の実施例である薄膜の測定方法を示す模式断面図、

第5図は、従来の膜厚を測定するための模式要部断面図である。

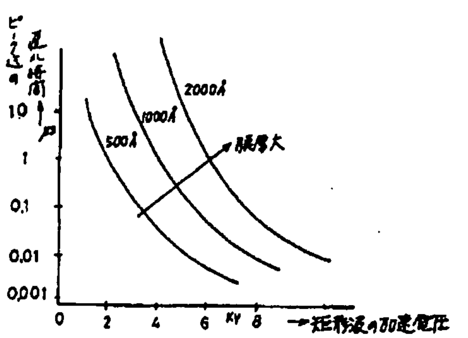
第6図は、従来の他の膜厚を測定するための模式要部断面図、

図において、

11はシリコン基板、　12は二酸化シリコン膜
13は接続端子　14はシンクロスコープ
15は矩形波の電子ビーム、
21はシリコン基板、　22は二酸化シリコン膜
23は凹部、　24は薄膜、
25は電子ビーム、　26はシンクロスコープ

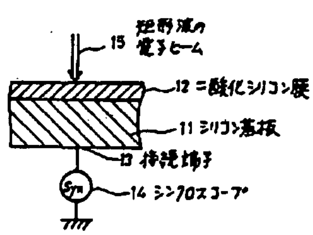
をそれぞれ示している。

代理人　弁理士　井桁貞一



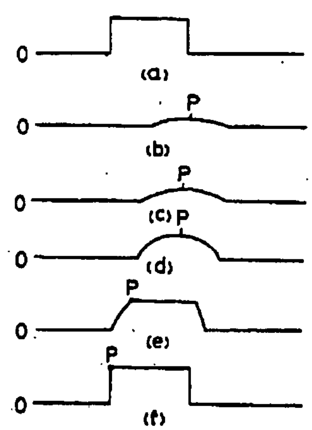
矩形波の加速電圧とピーク値の遅れ時間との相関図

第1図



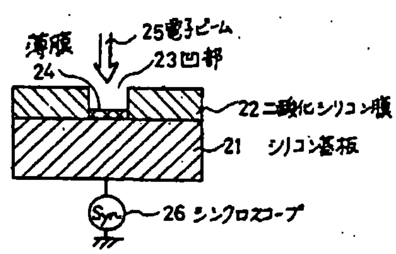
薄膜の測定方法を示す断面図

第2図



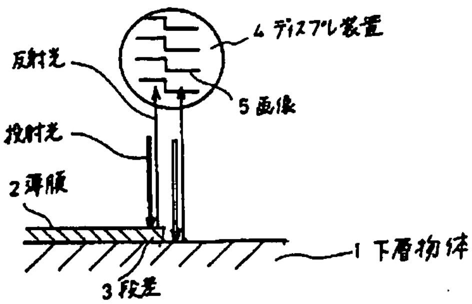
電流波形図

第3図



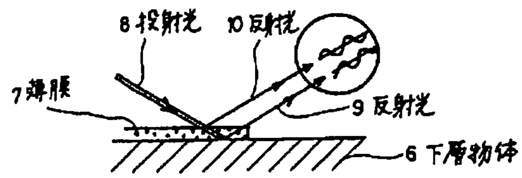
本発明の薄膜の測定方法を示す断面図

第4図



従来の膜厚を測定する方法を示す原理断面図

第 5 図



従来の膜厚を測定する方法を示す原理断面図

第 6 図

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(54) Title of the Invention: FILM THICKNESS MEASUREMENT METHOD

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SPECIFICATION

1. Title of the Invention

FILM THICKNESS MEASUREMENT METHOD

2. Claims

A film thickness measurement method which is characterized by the fact that an electron beam (15) with a pulse-form electron beam waveform is applied to the surfaces of films (12) that have respectively different thicknesses,

a correlation relationship (Figure 1) is determined in advance by measuring the lag time from the time of application of the current waveform that flows through the films to the [time of the] peak value in accordance with the respective film thicknesses,

when the thickness of a film is to be measured, an electron beam with a rectangular wave[form] is applied to this film, the lag time from the time of application of the current waveform that flows through this film to the [time of the] peak value is determined, and

the thickness of the film is measured by comparing this lag time with the above-mentioned correlation relationship.

3. Detailed Description of the Invention

(Outline)

The present invention is a film thickness measurement method for measuring extremely thin film thicknesses of 1000 Å or less. Furthermore, in this method, in order to measure the film thicknesses of films that are to be measured in a non-contact, non-destructive manner, the measurement of film thicknesses is accomplished by projecting an electron beam with a rectangular wave[form] whose acceleration voltage is varied onto the surface of a formed film, observing the waveform of the electron beam current with a rectangular wave[form] that flows through the film, and comparing [this waveform] with a chart in which the correlation of film thickness, acceleration voltage and waveform is determined beforehand.

(Field of Industrial Utilization)

The present invention relates to a film thickness measurement method, and more particularly relates to a method for measuring the thicknesses of extremely thin films by using an electron beam that has a rectangular wave[form].

As semiconductor devices have become more highly integrated, patterning has become finer as a result of increased density and fineness, and the formation of films with an extremely thin

formed film thickness has also become necessary. Furthermore, a need for the accurate measurement of such film thicknesses has arisen.

Conventionally, in the case of thin films with a thickness of approximately 1000 Å or less, the film thickness is measured by forming a step in thickness in the film that is being measured, projecting light onto this step, and performing measurements by an optical reflection method, or using a method in which the film thickness is measured by utilizing optical interfering light, etc.

However, in such cases, the object of measurement is destroyed; furthermore, such methods are in principle disadvantageous for the measurement of film thicknesses in the microscopic region by optical means, and the drawback of poor precision also arises.

For such reasons, there is a demand for a method that allows accurate measurement of the object of measurement under non-contact, non-destructive conditions even in the case of small film thicknesses in a small area.

(Prior Art)

Figure 5 is a model sectional view of essential parts of a conventional [apparatus] used to measure film thicknesses.

In cases where the object of measurement is made of silicon, etc., that reflects light, it is assumed that the lower-layer object 1 is made of (for example) silicon, and that (for example) a silicon dioxide film is present as a thin film 2 on the surface of this lower-layer object 1. In cases where the film thickness of this silicon dioxide film is measured, the following method is widely used: namely, a step 3 is formed by destroying the thin film 2, and light indicated by the arrow is projected onto this step part using (for example) a thallium light source, etc., with a wavelength of approximately 6000 Å, i.e., a light source which has a wavelength comparable to the film thickness. The reflected light arising from respective differences in the step is caused to draw an image in a display device 4, and the film thickness is measured from this image 5.

As another conventional measurement method, Figure 6 shows a system which is used to measure the film thickness of a light transmitting thin film 7 formed as an upper layer on the lower-layer object 6. In this method, projected light 8 is projected onto the thin film 7 constituting the object of measurement from an inclined direction, and this light passes through the thin film 7 and is reflected from the substrate 6. The thickness of the thin film is determined from the phase difference between this reflected light 9 and the reflected light 10 that is reflected from the surface of the thin film 6 [*sic*]*.

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* Translator's note: apparent error in the original for "thin film 7."

In the case of such conventional methods, the following drawbacks arise: namely, the reflected light or light refraction from the object of measurement of the light is also associated with the shape of the film thickness measurement region, and is therefore complex, so that the measurement precision is low. Furthermore, in cases where a step is formed in the object of measurement, the object of measurement must be destroyed.

(Problems that the Invention is to Solve)

In the case of film thickness measurement methods using such conventional optical methods, the following problems are encountered: namely, a step is formed by destroying the object of measurement; furthermore, the precision is low due to the complex optical characteristics of the object of measurement, and film thicknesses in regions with a small area cannot be measured, etc.

(Means for Solving the Problems)

The present invention provides a film thickness measurement method which solves the above-mentioned problems. The means used to solve the problems are devised so that an electron beam with a pulse-form electron beam waveform is applied to the surfaces of a plurality of films with different thicknesses, the lag time between the time of application of the current waveform that passes through the film and the [time of the] peak value is measured for films corresponding to the respective film thicknesses, a correlation relationship of the film thickness, acceleration voltage and lag time to the peak [value] of the current waveform is determined in advance, and when the thickness of a formed film is actually measured, an electron beam with a rectangular wave[form] is applied to this film, the lag time from the time of voltage application to the [time of the] peak value is measured from the current waveform that flows through the film, and the film thickness of the film is measured by comparing this measured value with the known correlation relationship.

(Operation)

The present invention utilizes the following fact: namely, when an electron beam that is accelerated by a specified acceleration voltage is projected onto a certain substance, the ultimate depth to which this electron beam penetrates into the substance is related only to the density that is peculiar to this substance and the acceleration voltage of the electron beam. Accordingly, if the ultimate depth reached by the electrons is greater than the film thickness, the current that flows through the film still has the same shape as the waveform of the original rectangular wave (the peak value of the waveform more or less coincides with the rise time). On the other hand, if the ultimate depth reached by the electrons is smaller than the film thickness, the current that

flows through the film has a waveform that differs considerably from the waveform of the original rectangular wave (the rectangular wave has a peak shape, and the peak value lags from the rise time).

Accordingly, if the current waveforms of the rectangular wave that pass through the film are measured in advance for substances with respectively different thicknesses using the acceleration voltage as a parameter, a correlation relationship of the acceleration voltage, lag time to the peak value of the waveform and film thickness is obtained for the [respective] substances.

Utilizing this known correlation relationship, an electron beam with a rectangular wave[form] is projected onto the actual film surface, and the film thickness is measured from the waveform of the current that passes through the film surface.

(Embodiments)

Generally, when an electron beam is projected onto a substance, the electrons reach a certain depth in the substance; in this case, the following universally known equation holds true:

$$R_g = 4.6 \times 10^{-6} E/\rho \qquad (1)$$

In Equation (1),

R_g = depth (cm) reached by electrons inside the substance
ρ = density of the substance (g/cm^3)
E = acceleration voltage (kV) of the electron beam

Accordingly, as the acceleration voltage increases, or as the density decreases, the electrons reach deeper portions of the substance; conversely, as the acceleration voltage decreases, or as the density increases, the electrons can reach only shallower portions of the substance.

Figure 1 is a diagram of the correlation between the time required for the rectangular wave[form] of an electron beam with a rectangular wave[form] passing through a thin film to reach the peak value from the time of application of the rectangular wave, and the acceleration voltage of this electron beam with a rectangular wave[form], in a case where such a thin film is formed from a specified substance, and such an electron beam with a rectangular wave[form] is projected onto this thin film. This correlation is expressed with the thickness of the thin film taken as a parameter.

Figure 2 is a sectional view illustrating the film thickness measurement method that is used in order to determine the above-mentioned relationship diagram.

A thin film comprising (for example) a silicon dioxide film 12 is formed on the surface of a silicon substrate 11, and the substrate is grounded by connection to a synchroscope 14 via a connection terminal 13. An electron beam 15 with a rectangular wave[form] which is accelerated at a specified acceleration voltage is projected onto a surface region of this thin film as indicated by the arrow [in Figure 2].

A beam current with a rectangular wave[form] flows through the silicon substrate 11 and silicon dioxide film 12, and the current waveform is detected by the synchroscope 14; accordingly, the lag time to the peak value can be determined from this waveform.

Figure 3 (a) through Figure 3 (f) respectively compare the electron beam with a rectangular wave[form] that is applied to the thin film, the thickness of the thin film, and the current waveform that passes through the substrate and thin film.

Figure 3 (a) shows the original rectangular wave[form] that is applied to the thin film, and Figures 3 (b) through 3 (f) show the film thicknesses when respective acceleration voltages of 5 kV, 10 kV and 20 kV are applied.

Specifically, the waveform shown in Figure 3 (b) indicates the waveform in the case of a thickness of 5000 Å at an acceleration voltage of 5 kV, a thickness of 15,000 Å at an acceleration voltage of 10 kV, and a thickness of 20,000 Å at an acceleration voltage of 20 kV.

Similarly, the waveform shown in Figure 3 (c) indicates the waveform in the case of a thickness of 4000 Å at an acceleration voltage of 5 kV, a thickness of 12,000 Å at an acceleration voltage of 10 kV, and a thickness of 40,000 Å at an acceleration voltage of 20 kV, the waveform shown in Figure 3 (d) indicates the waveform in the case of a thickness of 2000 Å at an acceleration voltage of 5 kV, a thickness of 6000 Å at an acceleration voltage of 10 kV, and a thickness of 20,000 Å at an acceleration voltage of 20 kV, the waveform shown in Figure 3 (e) indicates the waveform in the case of a thickness of 1000 Å at an acceleration voltage of 5 kV, a thickness of 3000 Å at an acceleration voltage of 10 kV, and a thickness of 10,000 Å at an acceleration voltage of 20 kV, and the waveform shown in Figure 3 (f) indicates the waveform in the case of a thickness of 500 Å at an acceleration voltage of 5 kV, a thickness of 1500 Å at an acceleration voltage of 10 kV, and a thickness of 5000 Å at an acceleration voltage of 20 kV.

Specifically, the waveform shown in Figure 3 (b) [*sic*] is a diagram of the current waveform that passes through the thin film and substrate, as measured by the synchroscope. As the acceleration voltage increases, or as the film thickness decreases, the diagram of the current waveform that passes through the thin film and substrate approaches the diagram of the original current waveform.

Accordingly, the film thickness can be measured by using the peak value (indicated by P in the figures) of the current waveform as a reference, and measuring the lag time of this value from the time of application of the original rectangular wave.

This lag time ranges from approximately n sec to m sec depending on the acceleration voltage.

Figure 4 is a model sectional view which illustrates a thin film measurement method constituting an embodiment of the present invention.

Here, it is assumed that a silicon dioxide film 22 is present on the surface of a silicon substrate 21, that a recessed part 23 with a diameter of a few microns is formed [in this silicon dioxide film 22], and that the thickness of a thin film 24 in this area is measured.

In this measurement method, the film thickness can easily be measured by constricting the beam spot of an electron beam 25 (which has a rectangular wave[form]) indicated by the arrow to match the dimensions of the thin film 24 located in the recessed part, projecting this beam onto the thin film, measuring the current waveform that is imaged by a synchroscope 26, measuring the lag of the peak value, and referring to the predetermined correlation diagram illustrated in Figure 1.

(Effect of the Invention)

Thus, as was described above in detail, the film thickness measurement method of the present invention makes it possible to measure the thicknesses of extremely thin films, and possesses great merit in that high-precision semiconductor devices with highly integrated circuits can be provided by accurate measurement of such film thicknesses.

4. Brief Description of the Drawings

Figure 1 is a correlation diagram of the time to the peak value of the rectangular wave and the acceleration voltage of the electron beam, with the film thickness used as a parameter.

Figure 2 is a model sectional view of essential parts used to illustrate the film thickness measurement method of the present invention.

Figures 3 (a) through 3 (f) are current waveform diagrams.

Figure 4 is a model sectional view which illustrates a thin film measurement method constituting an embodiment of the present invention.

Figure 5 is a model sectional view of essential parts illustrating a conventional [device used to] measure film thicknesses.

Figure 6 is a model sectional view of essential parts illustrating another conventional [device used to] measure film thicknesses.

In the figures, 11 indicates a silicon substrate, 12 indicates a silicon dioxide film, 13 indicates a connection terminal, 14 indicates a synchroscope, 15 indicates an electron beam with a rectangular wave[form], 21 indicates a silicon substrate, 22 indicates a silicon dioxide film, 23 indicates a recessed part, 24 indicates a thin film, 25 indicates an electron beam, and 26 indicates a synchroscope.

Agent: Sadakazu Itake, Patent Attorney [*seal*]

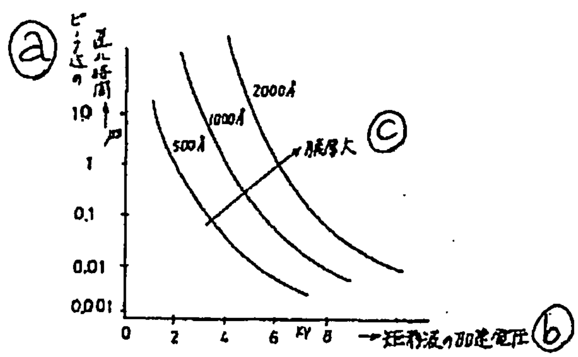

Figure 1
Correlation diagram of acceleration voltage of rectangular wave and lag time to peak

a: Lag time to peak (microseconds)
b: Acceleration voltage of rectangular wave
c: Increasing film thickness

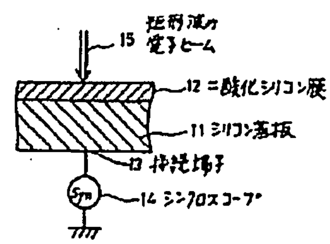

Figure 2
Sectional view illustrating thin film measurement method

11: Silicon substrate
12: Silicon dioxide film
13: Connection terminal
14: Synchroscope
15: Electron beam with rectangular wave[form]

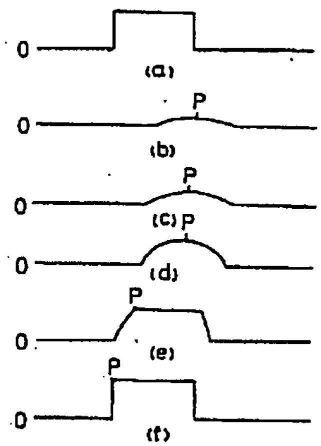

Figure 3
Current waveform diagrams

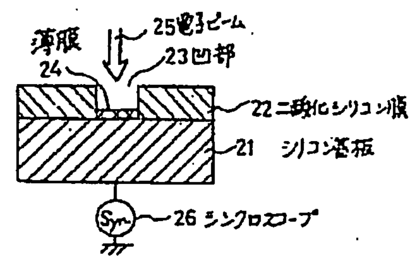

Figure 4
Sectional view
illustrating thin film measurement method
of the present invention

21: Silicon substrate
22: Silicon dioxide film
23: Recessed part
24: Thin film
25: Electron beam
26: Synchroscope

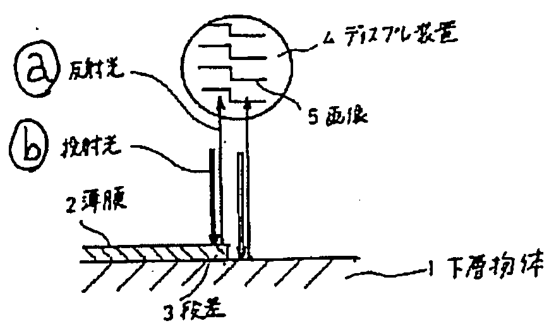

Figure 5
Sectional view
showing [operating] principle of a conventional film thickness measurement method

1: Lower-layer object
2: Thin film
3: Step
4: Display device
5: Image
a: Reflected light
b: Projected light

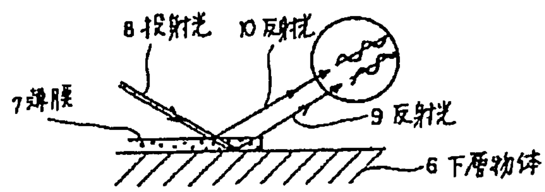

Figure 6
Sectional view
showing [operating] principle of a conventional film thickness measurement method

6: Lower-layer object
7: Thin film
8: Projected light
9: Reflected light
10: Reflected light